From:	Bruce Zook
To:	DaCruz, Pedro; Scott Perry
Cc:	Pence, Daniel; Bernhart, Michael R; Justin Miller
Subject:	RE: UV system- Control Program Improvements for Colorado Springs Utilities (Suez)
Date:	Thursday, June 21, 2018 8:04:49 AM
Attachments:	UV Bank Details.pdf UV Channels Hydraulic Analysis.pdf UV Flow Data Chart.pdf LVST UV Side Profile.pdf

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Sorry for the delay in getting back to you. We have been trying to get good data regarding our liquid levels in the channels but we are not able to pull a significant amount of data from the level sensor in the channel and therefore do not have confidence in correlating the level to the flow to verify the model therefore we think it is best to accept your model that correlated the flow to the water level in the channel (see the attached drawing - UV Channels Hydraulic Analysis) and provide flow rates.

According to drawing 18172-77-1222 (UV Channels Hydraulic Analysis), it seems the third bank (the most downstream) is the most submerged bank out of the three. The drawings seem to indicate that the recommended height of the weir trough was 63" (elevation of 76.08') rather than 62" (elevation of 75.997"). What is the liquid level assumed at the weir? In reviewing the drawings, it appears that the third bank (farthest downstream) is the most submerged which is in direct conflict with your statement below. Please help us understand how to interpret the drawings. A side profile drawing of the UV channels is attached for reference.

With our inability to get significant history for the liquid levels in the channel we decided to look at the flowrates through the UV system. From the data analysis of the different flowrates within the facility, the amount of low flow periods were minimal. From a sample group of 5 years at 1 hour intervals, 0.13% of the samples had flowrates below 10 MDG (see attached charts). There are two charts attached, the first shows the flow rates in 10MGD segments, the second breaks down the 10-20MGD flowrate in more detail. There is a separate chart that details the flow percentage within the 10-20 MGD range.

The data shows that the probability of a low flow event is relatively low and the duration of the low flow event is short- typically under 20 minutes. Under low flow, what is the concern for the system? We expect that the overheating of the bulbs is the primary concern. If it is then maybe this can be mitigated by our recommendation that we cap the power output to the bulbs at less than 100%. Also is it only a concern if a certain portion of the bulb is not submerged (is 2"-3" really an issue?). Or is the concern disinfection with the portion of the bulb that is not submerged providing no disinfection benefit. If this is the case then maybe the power could be slightly increased to compensate.

Is there a certain amount of time where a low flow condition can be tolerated before seeing any effect?

We look forward to working with you to come up with a flexible operational scheme that meets the requirements of the system. Please let us know if there is any further information we can provide.

Make it a great day

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From: DaCruz, Pedro [mailto:Pedro.DaCruz@suez-na.com]
Sent: Thursday, June 07, 2018 7:47 AM
To: Scott Perry <sperry@miscowater.com>; Bruce Zook <bzook@csu.org>
Cc: Pence, Daniel <Daniel.Pence@suez-na.com>; Bernhart, Michael R <Michael.Bernhart@suez-na.com>
Subject: RE: UV system- Control Program Improvements for Colorado Springs Utilities (Suez)

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Bruce / Scott,

Sorry for the delay as we had to look at some control options.

With regards to Bruce's request below, I would comment as follows:

1. Unfortunately due to the way the system is setup so it can handle the max flows and associated headlosses, changing the bank that turns on first won't be possible. The system is designed with steps assuming that the downstream banks will only come ON at very high flows where the water level will be sufficient to operate the lamps in that bank. Turning ON the most downstream bank at low flows and lower water levels would cause the lamps to be ON at water levels below the minimum recommended and lead to overheating and premature lamp failure. We do not recommend this option.
2. With regards to #2, I think there is an easier and better way to accomplish the same thing. Its my understanding that the UV system is operating at a lower UV dose than originally designed for and we have some flexibility in capacity. If that is the case, we would propose to actually lower the max setting for each lamp, so that in theory each lamp would work at for example maybe 80% of its max output before new lamps come on. This would spread out the wear over more lamps, more banks and would decrease the heat generated per bank. *Please confirm the current UV dose setpoint so that we can explore this option.*
3. This one shouldn't be a problem. It's not really in our scope, but we can give you or a third-party SCADA programmer a list of the tags they would need to monitor. That should be enough for them to go in grab what they need.

Let me know on #2 and we will look into this option.

Sincerely,

Pedro DaCruz
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From: Scott Perry <sperry@miscowater.com>
Sent: Tuesday, June 5, 2018 11:00 AM
To: Bruce Zook <bzook@csu.org>
Cc: Pence, Daniel <Daniel.Pence@suez-na.com>; DaCruz, Pedro <Pedro.DaCruz@suez-na.com>
Subject: RE: UV system- Control Program Improvements for Colorado Springs Utilities (Suez)

Bruce,
I spoke to Suez last week. They said we can do the controls upgrade you are looking for but it isn't as simple as it seems. I am copying Daniel Pence with Suez on this email and he is in charge of the group that will generate the quote for the controls upgrade you are looking for. I should have something for you this week. Thanks for your patience.

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From: Bruce Zook [mailto:bzook@csu.org]
Sent: Tuesday, June 05, 2018 8:28 AM
To: Scott Perry <sperry@miscowater.com>
Subject: RE: UV system- Control Program Improvements for Colorado Springs Utilities (Suez)

Please confirm that you received this. I need to get this moving. I'm starting to push a month now with no action that I can see.

Make it a great day

Bruce Zook
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From: Bruce Zook
Sent: Friday, June 01, 2018 9:07 AM
To: 'Scott Perry' <sperry@miscowater.com>
Subject: FW: UV system- Control Program Improvements for Colorado Springs Utilities (Suez)

I wondered if you had the ability to help move this request along a little bit.

I had a conversation with Michael Bernhart at Suez the week of May 11. It triggered the email train below. I sent the request to him 3 weeks ago to consider some changes that we would like to make. If they are not feasible or if Suez feels they would not be in our best interest then I would like to know why. We would like Suez to work with us to implement the changes requested (I expect they already have this in the current programming they have for their new systems they install) and have no problem paying them for their efforts.

But as you can see, I feel like we are stuck. I got a response that simply relayed a concern that I do not feel is valid and Michael said he needed to check with R&D. I understand that they need to make sure the requested changes are sound but I feel 3 weeks is ample time to do so. Can you help move this along?

I look forward to hearing from you.

Make it a great day

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From: Bruce Zook
Sent: Tuesday, May 29, 2018 12:51 PM
To: 'Bernhart, Michael R' <Michael.Bernhart@suez-na.com>
Cc: Eric Lindgren <elindgren@csu.org>; Gary Marshall <gmarshall@csu.org>
Subject: RE: UV system- Control Program Improvements for Colorado Springs Utilities

The UV dose is generally defined by the following equation:

$$D = I \times t \qquad (1)$$

where D = UV dose, $mW \cdot s/cm^2$

I = intensity of UV light, mW/cm^2

t = exposure time, s

This kind of confirmed what I was thinking. The exposure time could vary with the channel depth, but that can be compensated by increasing the intensity. The exposure time and intensity are inversely proportional so a 1% change in channel flow volume (LxWxD) would mean a 1.1% increase in intensity. It seems that this would be extremely easy to program.

I too saw that the channel is stepped down, but the depth of water is not increased by the amount of the step. The level of the water at the surface decreases also. The depth of water at the back end of the channel is about 2-3 inches more than the front end. You fully modeled the flow characteristics at the time of design so the depths are known at each bank and various flow rates. The depth at the last bank is deeper only to overcome pressure drop in flowing past the previous banks in the channel- the pressure drop is proportional to flow.

Maybe I am oversimplifying this but I think you have already modeled the flow dynamics and you have an existing algorithm to compute the intensity output. It should be very simple to build in the appropriate factor for the different banks based on the bank online. In fact, if you have not already done so I would be surprised because you had to do that in order to properly set the intensity for the first 2 banks when they are required to run. I would be very curious to understand how this is a consideration when it is the lead bank but not if it is the lag bank, it seems to me that calculation is identical.

I look forward to your response.

Make it a great day

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From: Bernhart, Michael R [mailto:Michael.Bernhart@suez-na.com]
Sent: Tuesday, May 29, 2018 9:14 AM
To: Bruce Zook <bzook@csu.org>; michael.bernhart@suez.com
Subject: RE: UV system- Control Program Improvements for Colorado Springs Utilities

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Bruce,

I am told the change you would like to see could change levels of disinfection since you have a stepped channel. The module on the influent side of the channel is 5 inches higher than the effluent module. To get a deeper explanation I need R&D to look at this. He has been out on another project but will see if he has returned.

Michael Bernhart
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From: Bruce Zook <bzook@csu.org>
Sent: Tuesday, May 29, 2018 11:06 AM
To: michael.bernhart@suez.com
Subject: RE: UV system- Control Program Improvements for Colorado Springs Utilities

It has been more than 2 weeks so hopefully you guys have been able to consider this more thoroughly by now and have an idea of a workable solution. I would love to hear from you.

Make it a great day

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From: Bruce Zook
Sent: Tuesday, May 15, 2018 11:32 AM
To: 'michael.bernhart@suez.com' <michael.bernhart@suez.com>
Subject: RE: UV system- Control Program Improvements for Colorado Springs Utilities

I only wanted to confirm that you received this, nothing else. Thank you.

Make it a great day

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From: Bruce Zook
Sent: Friday, May 11, 2018 9:18 AM
To: 'michael.bernhart@suez.com' <michael.bernhart@suez.com>
Cc: Eric Lindgren <elindgren@csu.org>; Gary Marshall <gmarshall@csu.org>
Subject: UV system- Control Program Improvements for Colorado Springs Utilities

It was good to talk to you yesterday. I apologize for not getting this out yesterday but you know how things go sometimes.

To follow up with our conversation, above is the descriptive summary for our system. To summarize, here is what we would like to accomplish:

1. The ability to run any one of the 3 banks in a specific channel as the lead. We see several benefits to this:
    a. We can equalize run time on the power supplies to the banks. As it is now one bank is taking over 80% of the run load and the power supplies in the first two banks (3 banks per channel) are going to need to be replaced well ahead of their full use.
    b. We can equalize run times on the bulbs. Again one bank is being heavily used and we are getting good use from those bulbs. The second to come on will be replaced based on the # of strikes, not hours, and the third bank (first in the flow path) see almost no use. In order to move the bulbs it is a major event and challenging to track the bulb location in the existing program.
    c. Similar to a) and b) above the air conditioners on the power supply cabinets are also loaded very differently and the AC on the lead bank are failing at a much higher rate. It would make it much easier to operate if we could select one of the other banks to be the lead if it was operating more reliably. This would allow us to fix any operational issues without missing a beat. I am told now that this is a cumbersome manual activity.
2. We would like to be able to change the setting where a second unit comes on. I am told not that does not occur until the lead bank reaches 100%. Considering the heat load and the degradation of the AC units on the power supplies we would like to be able to set this ourselves. There are times that we would like to reduce this to 80% or maybe down as low as 70% based on run condition of the equipment. It seems like we should be allowed this operational flexibility.
3. Ability to download bulb run times and strikes from the control system. I am told that right now the only means we have to do this is by walking through the local control panels and

writing down the values. This is a limitation in our asset management program.

I look forward to hearing back from you as to the potential improvements you can help us with on our control system. All of it is based on increasing reliability and getting maximum life out of the assets. We understand that some of this may mean that the system operates below its maximum efficiency but operation cost is not dependent solely on the cost of power fed to the unit.

I look forward to your response.

Make it a great day

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